Electronic Version
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Claims

[c1] What is claimed is:

1.A computer system comprising:

a host entity for issuing IO requests;

a redundant external storage virtualization controller (SVC) pair for performing IO operations in response to IO requests issued by the host entity comprising a first and a second external storage virtualization controller coupled to the host entity; and

a set of at least one physical storage device for providing storage to the computer system, with at least one member of said set of at least one physical storage device comprising a PSD coupled to the said redundant storage virtualization controller pair through a point-to-point serial signal interconnect;

wherein when one storage virtualization controller in the said redundant SVC pair is not on line or goes off line after being on line, the alternate storage virtualization controller in the said redundant SVC pair will automatically take over the functionality originally performed by the said one storage virtualization controller in the redundant SVC pair.

[c2] 2.The redundant storage virtualization computer system of claim 1 wherein said point-to-point serial signal interconnect is a Serial ATA IO device interconnect.

[c3] 3.The computer system of one of claims 1 and 2, wherein for at least one of the said physical storage devices, the computer system further comprises an access control switch coupled between each said physical storage device and the redundant storage virtualization controller pair for selectively switching the connection of the said physical storage device to the redundant SVC pair between the first and the second storage virtualization controller.

[c4] 4.The computer system of one of claims 1 and 2 wherein in the redundant storage virtualization controller pair, each of the storage virtualization controllers further comprises:
a central processing circuitry for performing IO operations in response to IO requests of said host entity;
at least one IO device interconnect controller coupled to said central processing circuitry;
at least one host-side IO device interconnect port provided in a said at least one IO device interconnect controller for coupling to said host entity; and
at least one device-side IO device interconnect port provided in a said at least one IO device interconnect con-

troller coupled to said at least one physical storage device through a point-to-point serial-signal interconnect.

[c5] 5.The storage virtualization computer system of claim 4 wherein a said host-side IO device interconnect port and a said device-side IO device interconnect port are provided in the same said IO device interconnect controller.

[c6] 6.The storage virtualization computer system of claim 4 wherein a said host-side IO device interconnect port and a said device-side IO device interconnect port are provided in different said IO device interconnect controllers.

[c7] 7.A redundant storage virtualization subsystem for providing storage to a host entity, comprising:
a redundant external storage virtualization controller (SVC) pair for performing IO operations in response to IO requests issued by the host entity comprising a first and a second storage virtualization controller for coupling to the host entity; and
a set of at least one physical storage device for providing storage to the host entity, with at least one member of said set of at least one physical storage device comprising a PSD coupled to the said redundant storage virtualization controller pair through a point-to-point serial signal interconnect;
wherein when one storage virtualization controller in the

said redundant SVC pair is not on line or goes off line after being on line, the alternate storage virtualization controller in the said redundant SVC pair will automatically take over the functionality originally performed by the said one storage virtualization controller in the redundant SVC pair.

[c8] 8.The redundant storage virtualization subsystem of claim 7 wherein the said point-to-point serial signal interconnect is a Serial ATA IO device interconnect.

[c9] 9. The redundant storage virtualization subsystem of one of claims 7 and 8, wherein at least one said PSD is installed in a canister removably attached to the redundant storage virtualization subsystem.

[c10] 10.The redundant storage virtualization subsystem of one of claims 7 and 8, wherein for each of at least one of the said physical storage devices, the redundant storage virtualization subsystem further comprises an access control switch coupled between said physical storage device and the redundant storage virtualization controller pair for selectively switching the connection of the said physical storage device to the redundant SVC pair between the first and the second storage virtualization controller.

[c11] 11. The redundant storage virtualization subsystem of claim 10, wherein at least one said PSD together with said access control switch is installed in a canister removably attached to the redundant storage virtualization subsystem.

[c12] 12.The redundant storage virtualization subsystem of claim 10 wherein said access control switch coupled between a said physical storage device and the redundant storage virtualization controller pair selectively allows patching through of the serial signal of the said physical storage device to and from the first SVC when in a first patching state of said access control switch and to and from the second SVC when in a second patching state of said access control switch.

[c13] 13. The redundant storage virtualization subsystem of claim 12, wherein an access ownership arbitration mechanism is provided between said SVC pair and said access control switch to control the patching state of said access control switch.

[c14] 14. The redundant storage virtualization subsystem of claim 13, wherein said access ownership arbitration mechanism comprises a pair of access request signal lines coupled between said SVC pair; said first SVC being active on a first of said access request signal line pair

and passive on a second of said access request signal line pair; said second SVC being active on said second and passive on said first of said access request signal line pair; and said SVC pair each being capable of issuing an access request signal on its own said active access request signal line, and reading a requesting state on its own said passive access request signal line and identifying a change of said requesting state since previous reading on its own said passive access request signal line.

[c15] 15. The redundant storage virtualization subsystem of claim 13, wherein said access ownership arbitration mechanism includes an access ownership detecting mechanism to determine if access ownership is possessed by a said SVC.

[c16] 16. The redundant storage virtualization subsystem of claim 13, wherein said access ownership arbitration mechanism includes an access ownership granting mechanism to grant access ownership when said access ownership is requested by a said SVC.

[c17] 17. The redundant storage virtualization subsystem of claim 13, wherein said access ownership arbitration mechanism comprises an access ownership arbitration circuit (AOAC) coupled to said first and second SVCs and

said access control switch, and wherein if said first SVC issues a first access ownership request signal received by said AOAC, access ownership will be granted to said first SVC when said second SVC does not already possess the access ownership, and if said second SVC issues a second access ownership request signal received by said AOAC, access ownership will be granted to said second SVC when said first SVC does not already possess the access ownership.

[c18] 18. The redundant storage virtualization subsystem of claim 17, further comprises an access ownership determining mechanism whereby when said first and said second SVC concurrently issue said first and second access ownership request signals to said AOAC, access ownership will be granted to a predetermined one of said SVC pair.

[c19] 19. The redundant storage virtualization subsystem of claim 10, further comprising a cooperating mechanism for the redundant SVC pair to cooperatively control a patching state of said access control switch; a monitoring mechanism for each SVC of said SVC pair to monitor status of the other SVC of said SVC pair; and, a state control mechanism for each SVC of said SVC pair to forcibly take complete control of said access control switch independent of the state the other SVC of said

SVC pair.

[c20] 20.The redundant storage virtualization subsystem of one of claims 7 and 8 wherein in the redundant storage virtualization controller pair, each of the storage virtualization controllers further comprises:
a central processing circuitry for performing IO operations in response to IO requests of said host entity;
at least one IO device interconnect controller coupled to said central processing circuitry;
at least one host-side IO device interconnect port provided in a said at least one IO device interconnect controller for coupling to said host entity; and
at least one device-side IO device interconnect port provided in a said at least one IO device interconnect controller coupled to at least one physical storage device through a point-to-point serial-signal interconnect.

[c21] 21.The redundant storage virtualization subsystem of claim 20 wherein a said host-side IO device interconnect port and a said device-side IO device interconnect port are provided in the same said IO device interconnect controller.

[c22] 22.The redundant storage virtualization subsystem of claim 20 wherein a said host-side IO device interconnect port and a said device-side IO device interconnect port

are provided in different said IO device interconnect controllers.

[c23] 23. The redundant storage virtualization subsystem of claim 20, wherein a logical media unit that is presented to said host entity through a first said host-side IO device interconnect port is also redundantly presented through a second said host-side IO device interconnect port.

[c24] 24. The redundant storage virtualization subsystem of claim 23, wherein the first said host-side IO device interconnect port and the second said host-side IO device interconnect port are IO device interconnect ports of the same one SVC in the redundant SVC pair.

[c25] 25. The redundant storage virtualization subsystem of claim 23, wherein the first said host-side IO device interconnect port is an IO device interconnect port of one SVC in the redundant SVC pair and the second said host-side IO device interconnect port is an IO device interconnect port of the other SVC in the redundant SVC pair.

[c26] 26. The redundant storage virtualization subsystem of claim 23, wherein the first said host-side IO device interconnect port and the second said host-side IO device interconnect port are coupled to the same host-side IO

device interconnect.

[c27] 27. The redundant storage virtualization subsystem of claim 26, wherein the first said host-side IO device interconnect port and the second said host-side IO device interconnect port are coupled to the said same host-side IO device interconnect through a switch circuit.

[c28] 28. The redundant storage virtualization subsystem of claim 23, wherein the first said host-side IO device interconnect port and the second said host-side IO device interconnect port are each coupled to a different host-side IO device interconnect.

[c29] 29. The redundant storage virtualization subsystem of claim 20, wherein at least one said host-side IO device interconnect port is Fibre Channel supporting point-to-point connectivity in target mode.

[c30] 30.The redundant storage virtualization subsystem of claim 20, wherein at least one said host-side IO device interconnect port is Fibre Channel supporting public loop connectivity in target mode.

[c31] 31.The redundant storage virtualization subsystem of claim 20, wherein at least one said host-side IO device interconnect port is Fibre Channel supporting private loop connectivity in target mode.

[c32] 32. The redundant storage virtualization subsystem of claim 20, wherein at least one said host-side IO device interconnect port is parallel SCSI operating in target mode.

[c33] 33.The redundant storage virtualization subsystem of claim 20, wherein at least one said host-side IO device interconnect port is ethernet supporting the iSCSI protocol operating in target mode.

[c34] 34. The redundant storage virtualization subsystem of claim 20, wherein at least one said host-side IO device interconnect port is Serial-Attached SCSI (SAS) operating in target mode.

[c35] 35. The redundant storage virtualization subsystem of claim 20, wherein at least one said host-side IO device interconnect port is Serial ATA operating in target mode.

[c36] 36. The redundant storage virtualization subsystem of one of claims 7 and 8, wherein an inter-controller communication channel is provided between the two SVCs in said redundant SVC pair for communicating state synchronization information.

[c37] 37. The redundant storage virtualization subsystem of claim 36, wherein said inter-controller communication

channel is an existing IO device interconnect, whereby inter-controller communication exchange is multiplexed with IO requests and associated data.

[c38] 38. The redundant storage virtualization subsystem of claim 36, wherein said inter-controller communication channel is a dedicated channel the primary function thereof is to exchange said state synchronization information.

[c39] 39. The redundant storage virtualization subsystem of claim 36, wherein said inter-controller communication channel is Fibre Channel.

[c40] 40. The redundant storage virtualization subsystem of claim 36, wherein said inter-controller communication channel is Serial ATA.

[c41] 41.The redundant storage virtualization subsystem of claim 36, wherein said inter-controller communication channel is Parallel SCSI.

[c42] 42.The redundant storage virtualization subsystem of claim 36, wherein said inter-controller communication channel is Ethernet.

[c43] 43.The redundant storage virtualization subsystem of claim 36, wherein said inter-controller communication

channel is Serial-Attached SCSI (SAS).

[c44] 44. The redundant storage virtualization subsystem of claim 36, wherein said inter-controller communication channel is I2C.

[c45] 45. The redundant storage virtualization subsystem of one of claims 7 and 8, wherein said redundant SVC pair can perform IO request rerouting function.

[c46] 46. The redundant storage virtualization subsystem of one of claims 7 and 8, wherein said redundant SVC pair can perform PSD access ownership transfer function.

[c47] 47. The redundant storage virtualization subsystem of one of claims 7 and 8, wherein at least one member SVC of said redundant SVC pair includes at least one expansion port for coupling to a second set of at least one PSD through a multiple-device device-side IO device interconnect.

[c48] 48. The redundant storage virtualization subsystem of claim 47, wherein members of a set of at least one said expansion port are mutually coupled together and to the said second set of at least one PSD through a switch circuit.

[c49] 49. The redundant storage virtualization subsystem of

claim 47, wherein members of a set of at least one said expansion port are mutually coupled together and to the said second set of at least one PSD directly without intervening circuitry.

[c50] 50. The redundant storage virtualization subsystem of claim 47, wherein a set of at least two said expansion ports form a redundant expansion port set for mutually performing IO request rerouting function whereby IO requests normally delivered to a PSD through a first member port of said redundant expansion port set may be rerouted through a second member port of said redundant expansion port set.

[c51] 51. The redundant storage virtualization subsystem of claim 47, wherein a member of said second set of at least one PSD has a pair of redundant ports with a member port of said redundant port pair being coupled to a set of at least one said expansion port.

[c52] 52. The redundant storage virtualization subsystem of claim 51, wherein IO request rerouting function can be performed through said redundant ports of said member of said second set of at least one PSD whereby IO requests normally delivered to a PSD through a first member port of said redundant port pair may be rerouted to said PSD through a second member port of said redun-

dant port pair.

[c53] 53. The redundant storage virtualization subsystem of claim 52, wherein a set of at least two said expansion ports form a redundant expansion port set for mutually performing IO request rerouting function whereby IO requests normally delivered to a PSD through a first member port of said redundant expansion port set may be rerouted through a second member port of said redundant expansion port set.

[c54] 54. The redundant storage virtualization subsystem of claim 51, wherein each member port in the said PSD redundant port pair is coupled to a different set of at least one expansion port.

[c55] 55. The redundant storage virtualization subsystem of claim 51, wherein said member port of redundant PSD port pair and said set of at least one said expansion port are mutually coupled together through a switch circuit.

[c56] 56. The redundant storage virtualization subsystem of claim 55, wherein said set of at least one expansion port comprises a first and a second expansion port subset forming a pair of complementary subsets with at least one member expansion port per subset.

[c57] 57. The redundant storage virtualization subsystem of

claim 56, wherein one of the interconnect signal line switching mechanisms implemented by said switch circuit is the coupling of said first subset of the said complementary subset pair to a first member port of said PSD redundant port pair and coupling of said second subset of the said complementary subset pair to a second member port of said PSD redundant port pair.

[c58] 58. The redundant storage virtualization subsystem of claim 56, wherein one of the interconnect signal line switching mechanisms implemented by said switch circuit is the coupling of both subsets of the said complementary subset pair to a first member port of said PSD redundant port pair.

[c59] 59. The redundant storage virtualization subsystem of claim 56, wherein one of the interconnect signal line switching mechanisms implemented by said switch circuit is the coupling of said first subset of the said complementary subset pair to a first member port of said PSD redundant port pair.

[c60] 60. The redundant storage virtualization subsystem of claim 56, wherein said switch circuit implements an interconnect signal line switching mechanism that supports all of the following arrangements:
(1) coupling of said first subset of the said complemen-

tary subset pair to a first member port of said PSD redundant port pair and coupling of said second subset of the said complementary subset pair to a second member port of said PSD redundant port pair;
(2) coupling of both subsets of the said complementary subset pair to said first member port of said PSD redundant port pair;
(3) coupling of both subsets of the said complementary subset pair to said second member port of said PSD redundant port pair;
(4) coupling of said first subset of the said complementary subset pair to said first member port of said PSD redundant port pair;
(5) coupling of said second subset of the said complementary subset pair to said second member port of said PSD redundant port pair;
(6) coupling of said second subset of the said complementary subset pair to said first member port of said PSD redundant port pair; and,
(7) coupling of said first subset of the said complementary subset pair to said second member port of said PSD redundant port pair.

[c61] 61. The redundant storage virtualization subsystem of claim 51, wherein said member port of redundant PSD port pair and said set of at least one said expansion port

are directly coupled together without intervening circuitry.

[c62] 62. The redundant storage virtualization subsystem of claim 51, wherein a member SVC of the redundant SVC pair further comprises at least two said expansion ports forming a redundant expansion port set.

[c63] 63. The redundant storage virtualization subsystem of claim 62, wherein a first and a second member port in the said redundant expansion port set are each coupled to a different one of member ports in redundant PSD port pair of a member PSD of said second set of at least one PSD.

[c64] 64. The redundant storage virtualization subsystem of claim 62, wherein a first and a second member port in the said redundant expansion port set are both coupled to the same one of member ports in redundant PSD port pair of a member PSD of said second set of at least one PSD.

[c65] 65.The redundant storage virtualization subsystem of claim 64, wherein said first and said second member port are directly connected to the same one of member ports in redundant PSD port pair of a member of said second set of at least one PSD without intervening cir-

cuitry.

[c66] 66. The redundant storage virtualization subsystem of claim 51 comprising:
a first expansion port set comprising at least one said expansion port on the first SVC in the redundant SVC pair;
a second expansion port set comprising at least one said expansion port on the second SVC in the redundant SVC pair;
wherein said first expansion port set and said second expansion port set together form a redundant expansion port set pair.

[c67] 67. The redundant storage virtualization subsystem of claim 66 wherein said first expansion port set and said second expansion port set are each coupled to a different one of member ports in redundant PSD port pair of each PSD of said second set of at least one PSD.

[c68] 68. The redundant storage virtualization subsystem of claim 66, wherein said first expansion port set and said second expansion port set are both coupled to the same one of member ports in redundant PSD port pair of each PSD of said second set of at least one PSD.

[c69] 69. The redundant storage virtualization subsystem of

claim 47, wherein at least one said expansion port is Fibre Channel.

[c70] 70. The redundant storage virtualization subsystem of claim 47, wherein at least one said expansion port is Parallel SCSI.

[c71] 71. The redundant storage virtualization subsystem of claim 47, wherein at least one said expansion port is Serial ATA.

[c72] 72. The redundant storage virtualization subsystem of claim 47, wherein at least one said expansion port is Ethernet.

[c73] 73. The redundant storage virtualization subsystem of claim 47, wherein at least one said expansion port is Serial-Attached SCSI (SAS).

[c74] 74. The redundant storage virtualization subsystem of one of claims 7 and 8, wherein said PSD is a SATA PSD.

[c75] 75. The redundant storage virtualization subsystem of one of claims 7 and 8, wherein said PSD is a PATA PSD.

[c76] 76. The redundant storage virtualization subsystem of one of claims 7 and 8, wherein each SVC in said redundant SVC pair includes a state-defining circuit for forcing externally connected signal lines of alternate SVC in said

redundant SVC pair to a predetermined state.

[c77] 77. The redundant storage virtualization subsystem of one of claims 7 and 8, wherein each SVC of said redundant SVC pair includes a self-killing circuit for forcing its own externally connected signal lines to a predetermined state.

[c78] 78.An external storage virtualization controller for use in a redundant storage virtualization controller pair, comprising:

a central processing circuitry for performing IO operations in response to IO requests of a host entity;

at least one IO device interconnect controller coupled to said central processing circuitry;

at least one host-side IO device interconnect port provided in a said at least one IO device interconnect controller for coupling to said host entity; and

at least one device-side IO device interconnect port provided in a said at least one IO device interconnect controller for performing point-to-point serial signal transmission with at least one physical storage devices;

wherein the said external storage virtualization controller will automatically take over the functionality originally performed by the alternate external storage virtualization controller in the said redundant storage virtualization controller pair when said alternate external stor-

age virtualization controller is not on line or goes off line after being on line.

[c79] 79.The storage virtualization controller of claim 78 wherein a said host-side IO device interconnect port and a said device-side IO device interconnect port are provided in the same said IO device interconnect controller.

[c80] 80.The storage virtualization controller of claim 78 wherein a said host-side IO device interconnect port and a said device-side IO device interconnect port are provided in different said IO device interconnect controllers.

[c81] 81.The storage virtualization controller of claim 78 wherein the a said at least one device-side IO device interconnect port comprises a Serial ATA interconnect port for connecting to a said physical storage device through a Serial ATA IO device interconnect.

[c82] 82. The storage virtualization controller of one of claims 78 and 81 further comprising a detection mechanism for detecting an off-line or failed state of said alternate storage virtualization controller.

[c83] 83. The storage virtualization controller of one of claims 78 and 81, wherein said SVC includes a state-defining circuit for forcing externally connected signal lines of alternate SVC in said redundant SVC pair to a predeter-

mined state.

[c84] 84. The storage virtualization controller of one of claims 78 and 81, wherein said SVC includes a self-killing circuit for forcing its own externally connected signal lines to a predetermined state.

[c85] 85. The storage virtualization controller of one of claims 78 and 81 wherein said functionality includes presenting and making available to the host entity accessible resources that were originally presented and made available by said alternate storage virtualization controller as well as accessible resources that were presented and made available by said storage virtualization controller itself.

[c86] 86. The storage virtualization controller of any one claims 78 and 81, wherein an access ownership arbitration mechanism is provided to determine which SVC in said SVC pair possesses access ownership.

[c87] 87. The storage virtualization controller of claim 86, wherein said access ownership arbitration mechanism includes an access ownership detecting mechanism to determine if access ownership is possessed by said SVC.

[c88] 88. The storage virtualization controller of claim 86, wherein said access ownership arbitration mechanism

includes an access ownership granting mechanism to grant access ownership when said access ownership is requested by a said SVC.

[c89] 89. The storage virtualization controller of one of claims 78 and 81, further comprising a cooperating mechanism for the redundant SVC pair to cooperatively control a patching state of an access control switch together with the alternate SVC; a monitoring mechanism for said SVC of said SVC pair to monitor status of the alternate SVC of said SVC pair; and, a state control mechanism for said SVC to forcibly take complete control of said access control switch independent of the state the alternate SVC of said SVC pair.

[c90] 90. The storage virtualization controller of one of claims 78 and 81, wherein an inter-controller communication port is provided for communicating state synchronization information between the said SVC and the alternate SVC in said redundant SVC pair.

[c91] 91. The storage virtualization controller of claim 90, wherein said inter-controller communication port is an existing IO device interconnect port, whereby inter-controller communication exchange is multiplexed with IO requests and associated data.

[c92] 92. The storage virtualization controller of claim 90, wherein said inter-controller communication port is a dedicated port the primary function thereof is to exchange said state synchronization information.

[c93] 93. The storage virtualization controller of claim 90, wherein said inter-controller communication port is Fibre Channel.

[c94] 94. The storage virtualization controller of claim 90, wherein said inter-controller communication port is Serial ATA.

[c95] 95.The storage virtualization controller of claim 90, wherein said inter-controller communication port is Parallel SCSI.

[c96] 96.The storage virtualization controller of claim 90, wherein said inter-controller communication port is Ethernet.

[c97] 97.The storage virtualization controller of claim 90, wherein said inter-controller communication port is Serial-Attached SCSI (SAS).

[c98] 98. The storage virtualization controller of claim 90, wherein said inter-controller communication port is I2C.

[c99] 99. The storage virtualization controller of one of claims

78 and 81, wherein said SVC can perform IO request rerouting function.

[c100] 100. The storage virtualization controller of one of claims 78 and 81, wherein said SVC can perform PSD access ownership transfer function.

[c101] 101. The storage virtualization controller of one of claims 78 and 81, wherein said SVC includes an expansion port for coupling to a second set of at least one PSD through multiple-device device-side IO device interconnects.

[c102] 102. The storage virtualization controller of one of claims 78 and 81, wherein at least one said host-side IO device interconnect port is Fibre Channel supporting point-to-point connectivity in target mode.

[c103] 103.The storage virtualization controller of one of claims 78 and 81, wherein at least one said host-side IO device interconnect port is Fibre Channel supporting public loop connectivity in target mode.

[c104] 104.The storage virtualization controller of one of claims 78 and 81, wherein at least one said host-side IO device interconnect port is Fibre Channel supporting private loop connectivity in target mode.

[c105] 105. The storage virtualization controller of one of claims 78 and 81, wherein at least one said host-side IO device interconnect port is parallel SCSI operating in target mode.

[c106] 106.The storage virtualization controller of one of claims 78 and 81, wherein at least one said host-side IO device interconnect port is ethernet supporting the iSCSI protocol operating in target mode.

[c107] 107. The storage virtualization controller of one of claims 78 and 81, wherein at least one said host-side IO device interconnect port is Serial-Attached SCSI (SAS) operating in target mode.

[c108] 108. The storage virtualization controller of one of claims 78 and 81, wherein at least one said host-side IO device interconnect port is Serial ATA operating in target mode.

[c109] 109.A method for performing storage virtualization in a computer system having a first and a second external storage virtualization controller configured into a redundant SVC pair, the method comprising:
in response to IO requests issued by an host entity of the computer system, performing IO operations by one storage virtualization controller in said redundant SVC pair

to at least one of physical storage device of the computer system using point-to-point serial signal transmission; and
when the said one storage virtualization controller in said redundant SVC pair is not on line or goes off line after being on line, performing the said IO operations by the alternate storage virtualization controller in said redundant SVC pair in response to said IO requests issued by said host entity to access said at least one physical storage device of the computer system using point-to-point serial signal transmission.

[c110] 110.The method of claim 109 wherein the point-to-point serial signal transmission is performed in a format complying with Serial ATA protocol.

[c111] 111. The method of one of claims 109 and 110 wherein said alternate storage virtualization controller will automatically take over the functionality originally performed by said one of the storage virtualization controllers when said one storage virtualization controller is not on line or goes off line after being on line.

[c112] 112. The method of claim 111 wherein said functionality includes presenting and making available to the host entity accessible resources that were originally presented and made available by said one of the storage virtualiza-

tion controllers as well as accessible resources that were presented and made available by said alternate storage virtualization controller itself.

[c113] 113. The method of one of claims 109 and 110, further comprising providing a rerouting mechanism for said redundant SVC pair to perform IO request rerouting function.

[c114] 114. The method of claim 113, wherein said IO request rerouting function is performed by the steps of:
a request initiator of said redundant SVC pair transferring an IO request to an access owner of said redundant SVC pair;
said access owner performing said IO request transferred from said request initiator.

[c115] 115. The method of claim 114, whereby at least some of the information and data associated with said IO request transferred between said access owner and said PSD are forwarded over to said request initiator.

[c116] 116. The method of one of claims 109 and 110, further comprising the steps of:
providing an access control switch coupled between a said at least one physical storage device and the redundant storage virtualization controller pair for selectively

allowing patching through of the serial signal of the physical storage device to and from the first SVC when in a first patching state of said access control switch and to and from the second SVC when in a second patching state of said access control switch.

[c117] 117. The method of claim 116, further comprising the steps of:
providing an access ownership arbitration circuit (AOAC) for acquiring access ownership of said access control switch;
said AOAC having a first access ownership request (AOR) signal line as a first input line thereof coupled to said first SVC, and said AOAC having a first output line coupled to a first access control switch control signal (ACSCS) input line of said access control switch;
said AOAC having a second access ownership request signal line (AOR) as a second input line thereof coupled to said second SVC, and said AOAC having a second output line coupled to a second access control switch control signal (ACSCS) input line of said access control switch; whereby
when one SVC of said redundant SVC pair asserts its AOR signal line while the alternate SVC of said redundant SVC pair having been asserting its AOR line, said ACSCS line of said one SVC will not be asserted until said alternate

SVC deasserts its said AOR line.

[c118] 118. The method of claim 117, further comprising the steps of:
providing said access ownership arbitration circuit a first alternate SVC access ownership request (ASAOR) signal line as a third output line thereof coupled to said second SVC;
providing said access ownership arbitration circuit a second alternate SVC access ownership request (ASAOR) signal line as a fourth input line thereof coupled to said first SVC; whereby
when a said access ownership request (AOR) signal line of one SVC of said redundant SVC pair is asserted while AOR of the other SVC of said redundant SVC pair is deasserted, ASAOR signal line coupled to said one SVC will be asserted indicating that access ownership is granted to said one SVC;
providing an access ownership determining mechanism for granting access ownership to one SVC of said redundant SVC pair when said first and second SVCs are asserting said AOR signal lines concurrently.

[c119] 119. The method of one of claims 109 and 110, further comprising providing an access ownership transferring mechanism for said SVC and the alternate SVC in the said redundant SVC pair to cooperatively transfer access

ownership back and forth therebetween.

[c120] 120. The method of claim 119, wherein information exchanges associated with access ownership transfer between said SVC pair are communicated as a part of inter-controller communications.

[c121] 121. The method of claim 119, wherein said access ownership transferring mechanism performs the steps of:
(a) access owner decides to relinquish said access ownership and transfer ownership to alternate SVC in redundant SVC pair;
(b) said access owner relinquishing said access ownership such that it is no longerthe access owner; and
(c) said alternate SVC acquiring said access ownership and becoming the new access owner of said PSD.

[c122] 122. The method of claim 121 wherein said decision to relinquish said access ownership and transfer ownership to alternate SVC is triggered by the said alternate SVC taking the role of access requester by issuing an access request indication to the said access owner to request access ownership transfer.

[c123] 123. The method of claim 122, further comprising the steps of:
providing a first signal line being of said first SVC active

and of said second SVC passive for issuing a first access request signal from said first SVC to said second SVC; providing a second signal line being of said second SVC active and of said first SVC passive for issuing a second access request signal from said second SVC to said first SVC;

said access requester of said SVC pair asserting its active signal line to request access ownership transfer of a said at least one PSD from said access owner of said redundant SVC pair;

said access owner deasserting its active signal line to relinquish said access ownership; and

said access requester asserting its active signal line and changing said patching state of said access control switch to acquire said access ownership.

[c124] 124. The method of claim 121, further comprising the steps of said access owner holding up and queuing up new IO requests for later execution and completing all pending IOs, after the step of (a) access owner decides to relinquish said access ownership and transfer ownership to alternate SVC and before the step of (b) said access owner relinquishing said access ownership.

[c125] 125. The method of claim 121, wherein said step of (b), "said access owner relinquishing said access ownership" further comprises modifying a state of an access control

switch coupled between said SVC pair and said PSD.

[c126] 126. The method of claim 121, wherein said step of (c), "said access requester acquiring said access ownership" further comprises modifying a state of an access control switch coupled between said SVC pair and said PSD.

[c127] 127.A computer-readable storage medium having a computer program code stored therein that is capable of causing a computer system having a host entity, a pair of external storage virtualization controllers coupled to the host entity and at least one physical storage device coupled to the pair of external storage virtualization controllers to perform the steps of:
performing IO operations by one of the SVCs in the said SVC pair in response to IO requests issued by the host entity to access at least one of the physical storage device in point-to-point serial signal transmission; and alternate SVC in said SVC pair automatically performing the IO operations that were originally performed by the said one of the SVCs in the said SVC pair in response to IO requests issued by the host entity to access at least one of the physical storage device in point-to-point serial signal transmission when the said one of the SVCs in the said SVC pair is not on line or goes off line after being on line.

[c128] 128.The computer readable medium of claim 127 wherein at least one of said at least one physical storage device is coupled to the said SVC pair through a Serial ATA IO device interconnect.

[c129] 129.A method for performing storage virtualization in a computer system having a first and a second external storage virtualization controller configured into a redundant SVC pair, the method comprising:
in response to IO requests issued by an host entity of the computer system, performing IO operations by one storage virtualization controller in said redundant SVC pair to at least one of physical storage device of the computer system; and
when the said one storage virtualization controller in said redundant SVC pair is not on line or goes off line after being on line, performing the said IO operations by the alternate storage virtualization controller in said redundant SVC pair in response to said IO requests issued by said host entity to access said at least one physical storage device of the computer system;
wherein IO request rerouting function is performed through a redundant IO device interconnect port pair comprising a first IO device interconnect port on said first SVC and a second IO device interconnect port on said second SVC.

[c130] 130. The method of claim 129 wherein said alternate storage virtualization controller will automatically take over the functionality originally performed by said one of the storage virtualization controllers when said one storage virtualization controller is not on line or goes off line after being on line.

[c131] 131. The method of claim 129, wherein said IO request rerouting function is performed by the steps of:
a request initiator of said redundant SVC pair transferring an IO request to an access owner of said redundant SVC pair;
said access owner performing said IO request transferred from said request initiator.

[c132] 132. The method of claim 131, whereby at least some of the information and data associated with said IO request transferred between said access owner and said PSD are forwarded over to said request initiator.

[c133] 133. The method of claim 129, wherein said redundant IO device interconnect port pair comprises a pair of device-side IO device interconnect ports.

[c134] 134. The method of claim 129, wherein said redundant IO device interconnect port pair comprises a pair of hybrid IO device interconnect ports which can be used as

device-side IO device interconnect ports for some IO operations and as host-side IO device interconnect ports for other IO operations.

[c135] 135. The method of one of claim 129, further comprising providing an access ownership transferring mechanism for said SVC and the alternate SVC in the said redundant SVC pair to cooperatively transfer access ownership back and forth therebetween.

[c136] 136. The method of claim 135, wherein information exchanges associated with access ownership transfer between said SVC pair are communicated as a part of inter-controller communications.

[c137] 137. The method of claim 135, wherein said access ownership transferring mechanism performs the steps of:
(a) access owner decides to relinquish said access ownership and transfer ownership to alternate SVC in redundant SVC pair;
(b) said access owner relinquishing said access ownership such that it is no longerthe access owner; and
(c) said alternate SVC acquiring said access ownership and becoming the new access owner of said PSD.

[c138] 138. The method of claim 137 wherein said decision to relinquish said access ownership and transfer ownership

to alternate SVC is triggered by the said alternate SVC taking the role of access requester by issuing an access request indication to the said access owner to request access ownership transfer.

[c139] 139. The method of claim 137, further comprising the steps of said access owner holding up and queuing up new IO requests for later execution and completing all pending IOs, after the step of (a) access owner decides to relinquish said access ownership and transfer ownership to alternate SVC and before the step of (b) said access owner relinquishing said access ownership.